

What is claimed is:

Sub A1
1. A method of compressing data including first and second data sets comprising:
transforming the first and second data sets into corresponding first and second
transform coefficient sets;
generating data representing differences between the first and second transform
coefficient sets; and
encoding the generated data for transmission.

10 2. The method of compressing data as recited in Claim 1, wherein transforming the first
and second data sets is performed utilizing a tensor product wavelet transform.

15 3. The method of compressing data as recited in Claim 2, wherein remainders from one
subband are transmitted to another subband.

4. The method of compressing data as recited in Claim 1, wherein generating data
representing differences between the first and second transform coefficient sets includes:
estimating the differences between the first and second transform coefficient sets to
provide motion vectors;
20 applying the motion vectors to the first transform coefficient set to produce a prediction
of the second transform coefficient set; and
subtracting the prediction from the second transform coefficient set resulting in a set of
prediction errors.

25 5. The method of compressing data as recited in Claim 4, wherein the first and second
transform coefficient sets are error corrected.

30 6. The method of compressing data as recited in Claim 4, wherein applying the motion
vectors to the first transform coefficient set further includes applying a mask about each
effected transform coefficient to obtain a weighted average of neighboring transform
coefficients.

35 7. The method of compressing data as recited in Claim 4, wherein estimating differences
between the first and second transform coefficient sets includes:
generating a search region about a subset of transform coefficients from one of the first
and the second transform coefficient sets;

applying a related subset of transform coefficients from the other of the first and the second transform coefficient sets to the search region; and

traversing incrementally the related subset of transform coefficients within the search region to a position representing a best incremental match.

8. The method of compressing data as recited in Claim 7, further including traversing fractionally the related subset of transform coefficients within the search region to a position representing a best fractional match.

9. The method of compressing data as recited in Claim 1, wherein transforming of the first and second data sets produces the first transform coefficient set as a first collection of subbands and the second transform coefficient set as a second collection of subbands.

10. The method of compressing data as recited in Claim 9, further including macro-block packing the second collection of subbands to form a subband macro-block grouping.

11. The method of compressing data as recited in Claim 10, further including applying weighting to subband macro-blocks within the subband macro-block grouping.

12. The method of compressing data as recited in Claim 10, further including detecting changes between the subband macro-block grouping and a reference.

13. The method of compressing data as recited in Claim 12, wherein detecting changes between the subband macro-block grouping and the reference is based on a distortion evaluation according to a general equation of the form:

$$e_c = \sum_i W_i \|G - R\|_x^{P_x}$$

14. The method of compressing data as recited in Claim 13, wherein detecting changes between the subband macro-block grouping and the reference is based on a distortion evaluation according to an equation of a more specific form:

$$e_c = W_0 \|G - R\|_1^2 + W_1 \|G - R\|_\infty^2$$

15. The method of compressing data as recited in Claim 10, wherein generating data representing differences between the first and second transform coefficient sets includes:

estimating the differences between the first collection of subbands and the subband macro-block grouping to provide motion vectors;

applying the motion vectors to the first collection of subbands to produce a prediction of the second collection of subbands; and

5 subtracting the prediction from the second collection of subbands resulting in a set of prediction errors.

16. The method of compressing data as recited in Claim 15, wherein estimating the differences between the first collection of subbands and the subband macro-block grouping
10 includes:

generating a search region about a subset of transform coefficients from the first collection of subbands;

applying a related subset of transform coefficients from the subband macro-block grouping to the search region; and

15 traversing incrementally the related subset of transform coefficients within the search region to a position representing a best incremental match.

17. The method of compressing data as recited in Claim 16, further including traversing fractionally the related subset of transform coefficients within the search region to a position
20 representing a best fractional match.

18. The method of compressing data as recited in Claim 1, wherein encoding the generated data for transmission further includes identifying subsets of the generated data that are equal to
25 zero.

19. A method of compressing data including first and second data sets comprising:

transforming the first data set and the second data set into corresponding first and second transform coefficient sets;

estimating differences between the first and second transform coefficient sets to provide
30 motion vectors;

predicting the second transform coefficient set by applying the motion vectors to the first transform coefficient set;

subtracting the predicted second transform coefficient set from the second transform coefficient set to obtain prediction errors; and

35 encoding the prediction errors and the motion vectors for transfer to a decoder.

20. The method of compressing data as recited in Claim 19, wherein transforming the first data set and the second data set is carried out utilizing a tensor product wavelet transform.

21. The method of compressing data as recited in Claim 19, wherein estimating differences between the first and second transform coefficient sets includes:

generating a search region about a subset of transform coefficients from one of the first and the second transform coefficient sets;

applying a related subset of transform coefficients from the other of the first and the second transform coefficient sets to the search region; and

traversing incrementally the related subset of transform coefficients within the search region to a position representing a best incremental match.

22. The method of compressing data as recited in Claim 21, further including traversing fractionally the related subset of transform coefficients within the search region to a position representing a best fractional match.

23. The method of compressing data as recited in Claim 19, wherein transforming of the first data set and the second data set produces the first transform coefficient set as a first collection of subbands and the second transform coefficient set as a second collection of subbands.

24. The method of compressing data as recited in Claim 23, further including macro-block packing the second collection of subbands to form a subband macro-block grouping.

25. The method of compressing data as recited in Claim 24, further including applying weighting to subband macro-blocks which make up the subband macro-block grouping.

26. The method of compressing data as recited in Claim 24, further including detecting changes between the subband macro-block grouping and a reference.

27. The method of compressing data as recited in Claim 26, wherein detecting changes between the subband macro-block grouping and a reference is based on a distortion evaluation according to a general equation of the form:

$$e_c = \sum_i W_i \|G - R\|_x^{p_x}$$

28. The method of compressing data as recited in Claim 19, wherein encoding the prediction errors and the motion vectors for transfer to the decoder further includes identifying subsets of the prediction errors that are equal to zero.

5 29. A method of compressing data including first and second data sets comprising:
transforming the first data set and the second data set into corresponding first and
second transform coefficient sets;
estimating differences between the first and second data sets to provide motion vectors;
predicting the second transform coefficient set by applying the motion vectors to the
10 first transform coefficient set; and
subtracting the predicted second transform coefficient set from the second transform
coefficient set to obtain prediction errors.

15 30. The method of compressing data as recited in Claim 29, wherein the first transform
coefficient set is error corrected.

31. A method of compressing data in an encoder to reduce the number of bits transferred to
a decoder comprising:
transforming a first data set and a subsequent second data set producing corresponding
20 first and second transform coefficient sets;
estimating differences between the first and second data sets to provide motion vectors;
predicting the second transform coefficient set by applying the motion vectors to the
first data set and thereafter transforming the prediction results; and
subtracting the transformed prediction results from the second transform coefficient set
25 to obtain prediction errors.

32. The method of compressing data as recited in Claim 31, further including inverse
transforming the first transform coefficient set and providing the first transform coefficient set
as a reference during predicting.

30 33. The method of compressing data as recited in Claim 32, wherein the first transform
coefficient set is error corrected.

34. A method of packing subband blocks that correspond to a subset of a data set
35 comprising:
disassociating a set of related subband blocks from a collection of subbands;
packing the set of related subband blocks together as a subband macro-block; and

repeating the disassociating and packing steps above for each set of related subband blocks in the collection of subbands to form a subband macro-block grouping.

35. The subband macro-block packing method as recited in Claim 34, wherein the packing step includes arranging the set of related subband blocks within the subband macro-block in the same relative position the subband blocks occupied in the collection of subbands.

36. The subband macro-block packing method as recited in Claim 34, wherein the packing step includes locating the subband macro-block within the subband macro-block grouping in the same spatial location as the corresponding data subset is located within the data set.

37. A method for transforming a data set into transform coefficients comprising transforming the data set utilizing a tensor product wavelet transform having at least two filter paths and propagating remainders derived during transforming between at least two of the filter paths.

38. The method as recited in Claim 37, wherein the remainders from a first filter path of the at least two filter paths are propagated to a second filter path of the at least two filter paths and the remainders from the second filter path are propagated to the first filter path.

39. The method as recited in Claim 37, wherein the tensor product wavelet transform is a tensor product wavelet pair for determining a high pass component and a low pass component.

40. The method as recited in Claim 39, wherein transforming of the data set and propagating remainders between the filter paths includes:

determining the low pass component and the high pass component of the data set;

normalizing the low pass component to generate a low pass normalized output and a first remainder (rl);

normalizing the high pass component to generate a high pass normalized output and a second remainder (rh);

performing a first operation ($g(rl, rh)$) on the first and second remainders (rl, rh) and adding the results emanating therefrom to the low pass normalized output to generate an approximation; and

performing a second operation ($f(rl, rh)$) on the first and second remainders (rl, rh) and adding the results emanating therefrom to the high pass normalized output to generate a detail.

41. The method as recited in Claim 40, further including downsampling the low pass component and the high pass component.

42. The method as recited in Claim 39, wherein the low pass component is determined utilizing a filter having the value -1, 2, 6, 2, -1; the high pass component is determined utilizing a filter having the value -1, 2, -1; and further including a first operation ($g(r_l, r_h)$) and a second operation ($f(r_l, r_h)$) having functions as follows:

$$g(r_l, r_h) = r_h; \text{ and}$$

$$f(r_l, r_h) = \text{floor}(r_h + \frac{1}{2}), \text{ where } nh = \frac{1}{2}.$$

43. The method as recited in Claim 39, wherein the tensor product wavelet pair is of the form:

$$D_i = X_{2i} - \left\lfloor \frac{X_{2i-1} + X_{2i+1}}{2} \right\rfloor; \text{ and}$$

$$A_i = X_{2i+1} + \left\lfloor \frac{D_i + D_{i+1} + 2}{4} \right\rfloor.$$

44. A method of encoding a data set into transform coefficients comprising transforming the data set utilizing an encoding technique and propagating remainders derived during encoding from a first filter path to a second filter path of the encoder.

45. The method of encoding as recited in Claim 44, further including propagating remainders from the second filter path to the first filter path.

46. The method of encoding as recited in Claim 44, wherein the encoding technique is a tensor product wavelet transform.

47. The method of encoding as recited in Claim 44, wherein the encoding technique is a discrete cosine transform.

48. A method of encoding a data set comprising:

determining a first filter component of the data set in a first filter path;

determining a second filter component of the data set in a second filter path;

normalizing the first filter component to generate a normalized output and a remainder;

and

propagating the remainder to the second filter path.

49. A method of estimating changes occurring between a first data set and a second data set comprising:

5 generating a search region about a data subset from one of the first and second data sets;

applying a related data subset from the other of the first and second data sets to the search region; and

10 traversing incrementally the related data subset within the search region to a position representing a best incremental match.

50. The method of estimating changes occurring between a first data set and a second data set as recited in Claim 49, further including traversing fractionally the related data subset within the search region to a position representing a best fractional match.

15 51. An encoder apparatus comprising:

a transformation device, having an input configured to receive a first and second set of data, and further configured to generate a corresponding first and second collection of subbands; and

20 a motion compensation device, having an input coupled to the transformation device, configured to receive the first and second collection of subbands, and further configured to efficiently represent differences between the first and second collection of subbands.

25 52. The encoder apparatus as recited in Claim 51, wherein the motion compensation device carries out all operations on the first and second collection of subbands in the transform domain.

30 53. The encoder apparatus as recited in Claim 51, further including a difference block that is configured to receive a prediction from the motion compensation device and the second collection of subbands from the transformation device, and further configured to determine the difference between the prediction and the second collection of subbands for generating a prediction error.

35 54. The encoder apparatus as recited in Claim 51, wherein the motion compensation device includes:

a motion estimation device, coupled to the transformation device, configured to compare the first and second collection of subbands to generate motion vectors; and

a motion prediction device, coupled to the motion estimation device and the transformation device, configured to receive the motion vectors and the first collection of subbands, and further configured to generate a prediction of the second collection of subbands.

5 55. An encoder apparatus for detecting changes comprising:

a transformation device, having an input configured to receive a first data set and a second data set, and further configured to respectively generate therefrom a first collection of subbands and a second collection of subbands; and

10 a macro-block packing device having an input coupled to the transformation device and configured to receive the first collection of subbands and the second collection of subbands, and further configured to respectively generate a first subband macro-block representation and a second subband macro-block representation.

15 56. The encoder apparatus as recited in Claim 55, further including a weighting device having an input configured to communicate with the macro-block packing device and configured to receive and then scale the first subband macro-block representation and the second subband macro-block representation based on perceptual importance.

20 57. The encoder apparatus as recited in Claim 55, further including a change-detect device, having an input configured to communicate with the macro-block packing device and configured to compare the first subband macro-block representation and the second subband macro-block representation to determine the changes therebetween, the change-detect device further configured to generate a change-detected grouping which reflects the changes.

25 58. The encoder apparatus as recited in Claim 57, further including a macro-block ranking device having an input coupled to the change-detect device and configured to rank the change-detected grouping.

30 59. The encoder apparatus as recited in Claim 57, wherein the comparison of the first subband macro-block representation and the second subband macro-block representation is based on a distortion evaluation according to the general equation:

$$e_c = \sum_i W_i \|G - R\|_x^{P_x}.$$

60. The encoder apparatus as recited in Claim 59, wherein the comparison of the first subband macro-block representation and the second subband macro-block representation is based on a distortion evaluation according to an equation of a more specific form:

$$e_c = W_0 \|G - R\|_2^2 + W_1 \|G - R\|_\infty^2.$$